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Title

**EOC Implementation of the RRES-ECO
Wildfire Behavior Modeling System: Final Report**

Principal Investigators

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EOC Implementation of the RRES-ECO Wildfire Behavior Modeling System: Final Report

With the support of the Cerro Grande Rehabilitation Project (CGRP) Office, the Ecology Group (RRES-ECO) has been working to implement and install the RRES-ECO Wildfire Behavior Modeling System at the Emergency Operations Center (EOC) of Los Alamos National Laboratory (LANL). This involved several subtasks (Balice et al. 2002a). The current document is a final report of these activities to upgrade the wildfire behavior model and install it in the EOC. In summary, we completed the project before the agreed upon deadline of May 31, 2002, and we completed the project within the budgetary guidelines.

This project involved several steps. These steps included the reorganization and simplification of the modeling system, the compilation of standard weather data, the establishment of fuel characteristics for thinned ponderosa pine forests and piñon-juniper woodlands, and the installation of the completed system at the EOC.

First, the executable files and the input data files for the RRES-ECO Wildfire Behavior Modeling System were adopted from those developed under a previous three-year research project (Balice et al. 2000a, 2002b, 2002c). These files were reorganized into convenient subdirectories and renamed for easy access by the general user. At the conclusion of this reorganization, the entire system was exhaustively tested to ensure that it would perform at the level that had been previously established through sensitivity analyses and validation testing.

Second, we compiled Farsite-readable files of standard wind and weather conditions. This was done in accordance with methods that had been previously established (Balice et al. 2000a). The advantage of creating these additional wind and weather files is that a variety of types of wildfires can be modeled quickly without the need for time-consuming editing of files or creating new files. This compilation may prove to be of critical, time-saving importance during an actual wildfire emergency.

To accomplish this second task, wind and weather data for the time period from January 1, 2001, to March 31, 2002, were accessed from the LANL Weather Machine (Baars et al. 1998, Air Quality Group 2001). Within this time period, graphs of temperatures and average wind speed were reviewed and six five-day periods of stable temperature and stable wind speed patterns were selected (Attachment 1). These five-day periods were categorized into low, moderate, and high wildfire conditions (Attachment 2). Then Farsite files of wind and weather information were created for each of these six time periods from the Technical Area (TA) 6, TA-54, TA-49, and Pajarito Mountain weather towers. Finally, these wind and weather files were combined with files previously compiled for the May 7, 2000, time period (high-extreme wildfire weather conditions) and the May 10, 2000, time period (extreme wildfire weather conditions).

Third, fuel input data needed to be updated to reflect LANL forest thinning operations after the Cerro Grande Fire. The fuel characteristics for the RRES-ECO Wildfire Behavior

Modeling System had been previously developed under a three-year research project (Balice et al. 2000a, 2002b, 2002c). These results had been developed through the use of data collected at a system of permanent plots established before the Cerro Grande Fire (Balice et al. 1999, 2000b). We used recently collected data to update these fuels characteristics to match the conditions that were observed to occur in ponderosa pine forests and in piñon-juniper woodlands after thinning operations. Under the assumption that wildfire behavior modeling is concerned with fuel structures and conditions as they exist today, no attempt was made to predict future conditions during this exercise.

To accomplish this we reformatted data collected at permanent plots after the Cerro Grande Fire in forested and wooded areas that were scheduled to be thinned and were currently being monitored for pretreatment and posttreatment conditions or for demonstration purposes (Balice 2001a, 2001b). The plots had been sampled during the 2001 field season. The data from the unthinned plots were then scaled to each of the following thinned conditions; general thinning, fuelbreak thinning, defensible space thinning, and powerline thinning (Attachment 3). This was done for the fuel models, canopy heights, canopy cover percents, crown base heights, and canopy bulk densities, for both ponderosa pine forests and piñon-juniper woodlands. The prethinned values for these parameters were reduced in proportion to the number of trees that would remain after the thinning targets are achieved.

Finally, the entire system was installed on a computer at the EOC. The complete system includes the Farsite executable files, Behave Plus executable files, the geographic information system input data layers, the standard weather files, and a list of contacts. The installed system was further tested to determine that it would function as expected during an actual wildfire emergency.

Acknowledgments

We gratefully acknowledge the Cerro Grande Rehabilitation Project for funding this project. We would also like to thank the Environment, Safety and Health Division's Technology Development, Evaluation, and Assessment Program for providing funds to develop, parameterize, and compile the original modeling system. Thanks are also extended to Gene Darling, Manny L'Esperance, and Dave Howard of the Emergency Operations Office for their assistance and support. Brad McKown compiled the low-, moderate-, and high-weather data that were converted to standard weather files. Diana McPherson reformatted the permanent plot data that was used to estimate the fuels after thinning.

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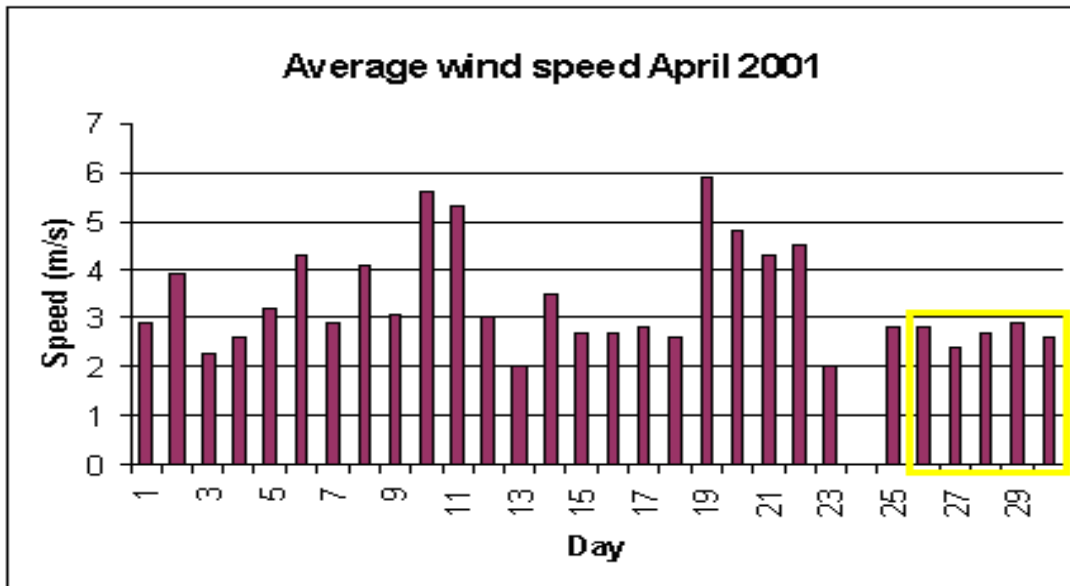
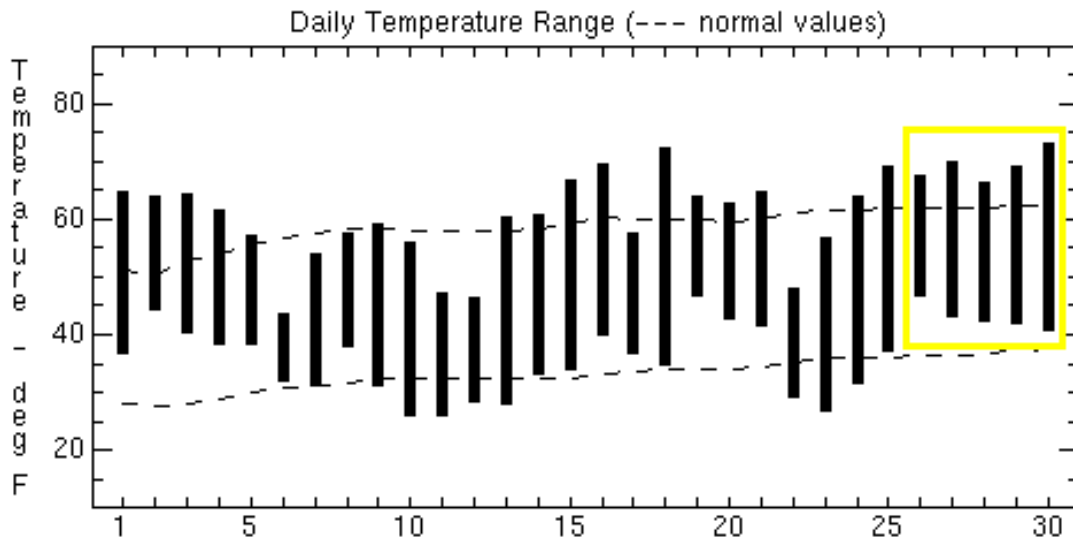
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Attachment 1

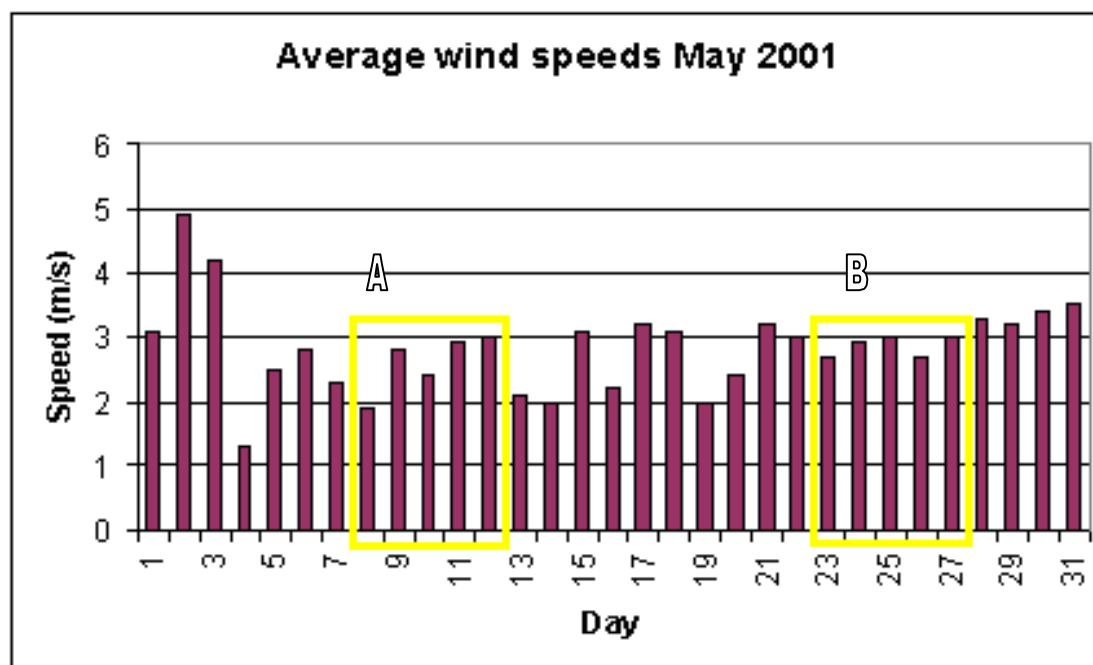
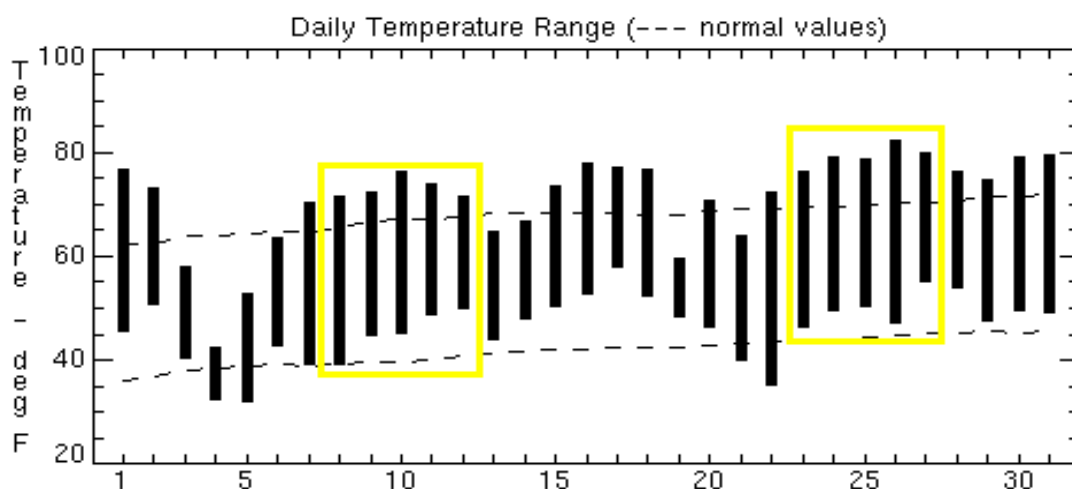
Weather and wind summaries with stable weather periods in highlights.

Weather Summary for April 2001 **Los Alamos, NM, TA-6 Station, Elevation 7424 ft**



April 26th-30th, 2001: Moderate conditions. Average temperatures slightly higher than normal, but average wind speeds below 3 m/s (6.7 mph). In actual data 0.2 inches of precipitation was recorded on the 27th and 0.05 inches on the 28th.

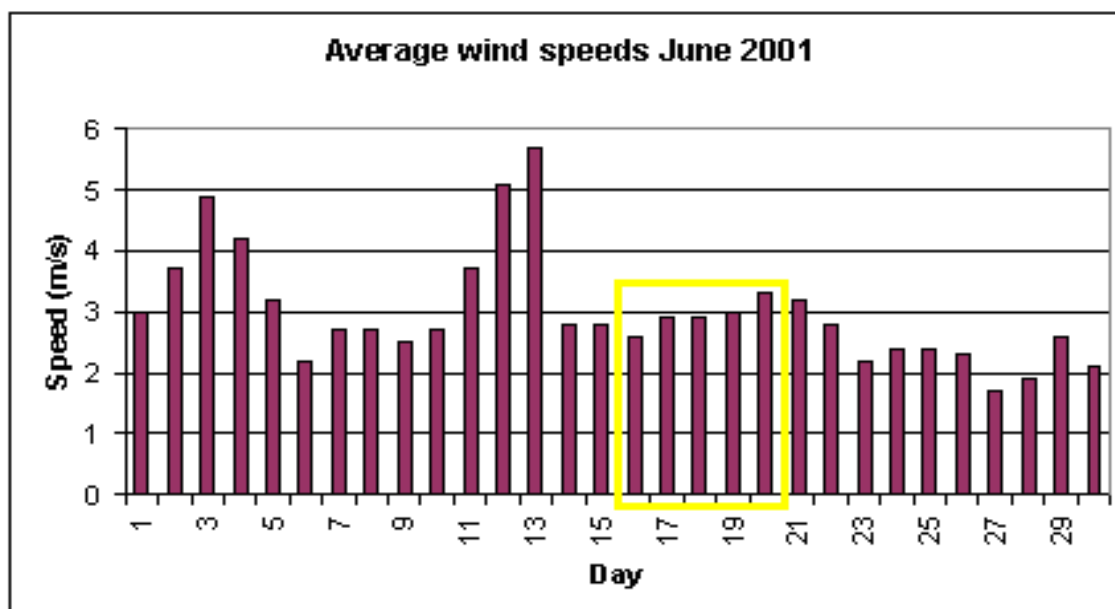
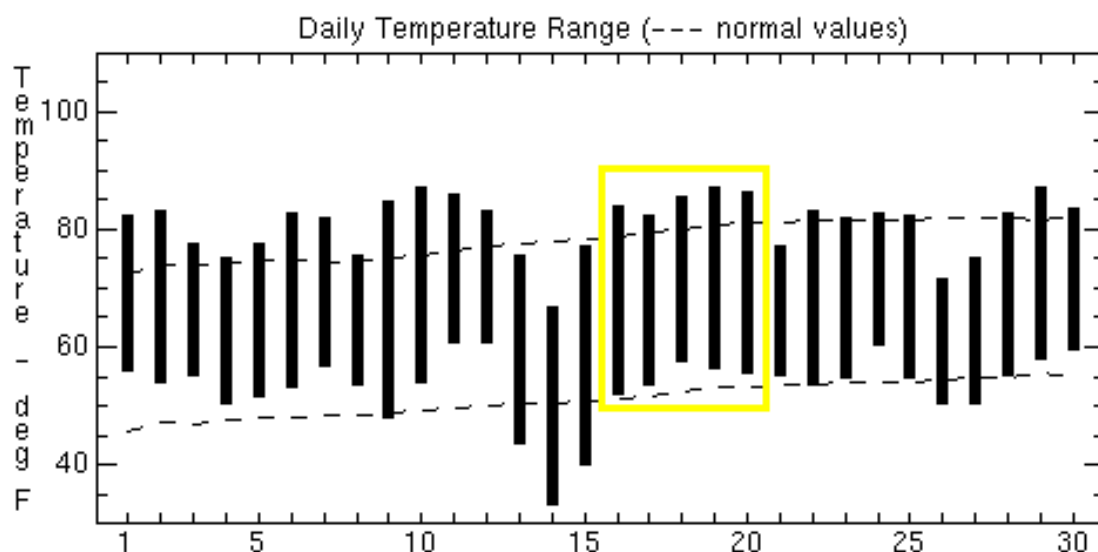
Weather Summary for May 2001 **Los Alamos, NM, TA-6 Station, Elevation 7424 ft**



A- May 8th-12th, 2001: Moderate. Slightly higher temperatures than normal but average wind speeds below 3 m/s (6.7 mph). First day slightly lower average wind speeds. In actual data 0.1 inches of precipitation was recorded on the 12th.

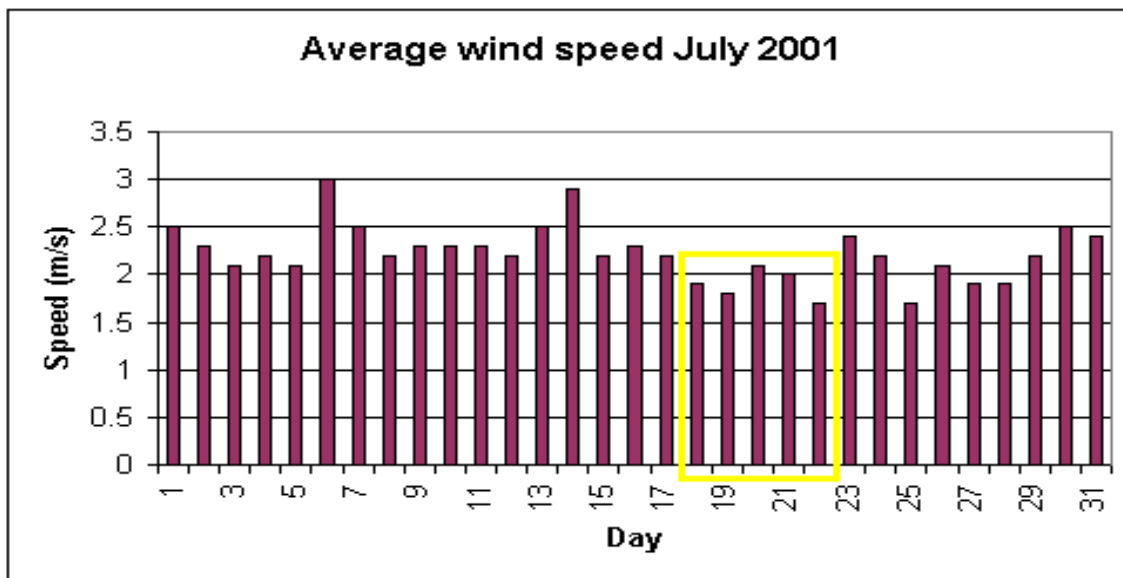
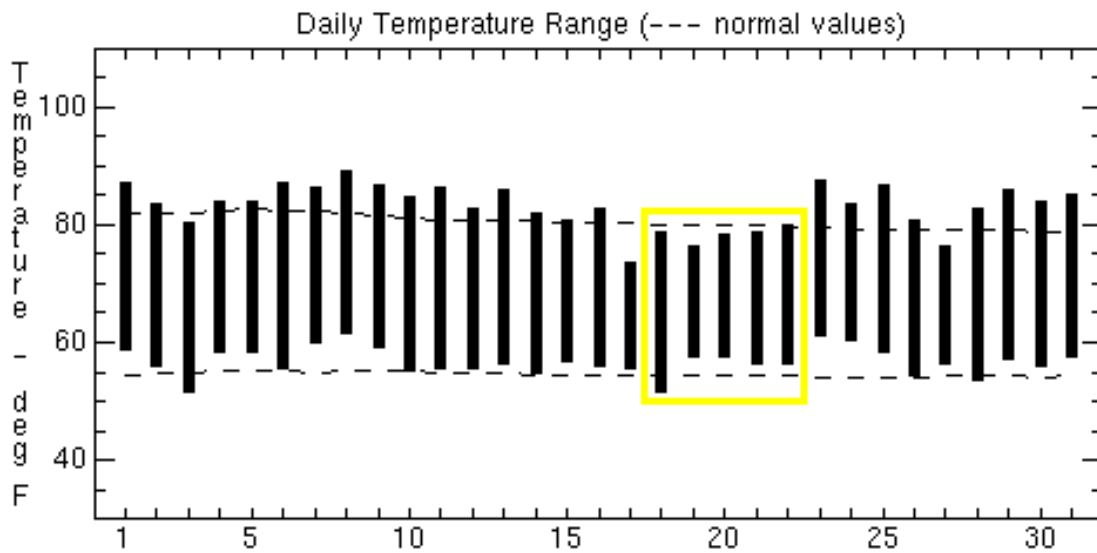
B- May 23rd-27th, 2001: Moderate. Slightly higher temperatures than normal but average wind speeds below 3 m/s (6.7 mph).

Weather Summary for June 2001 **Los Alamos, NM, TA-6 Station, Elevation 7424 ft**



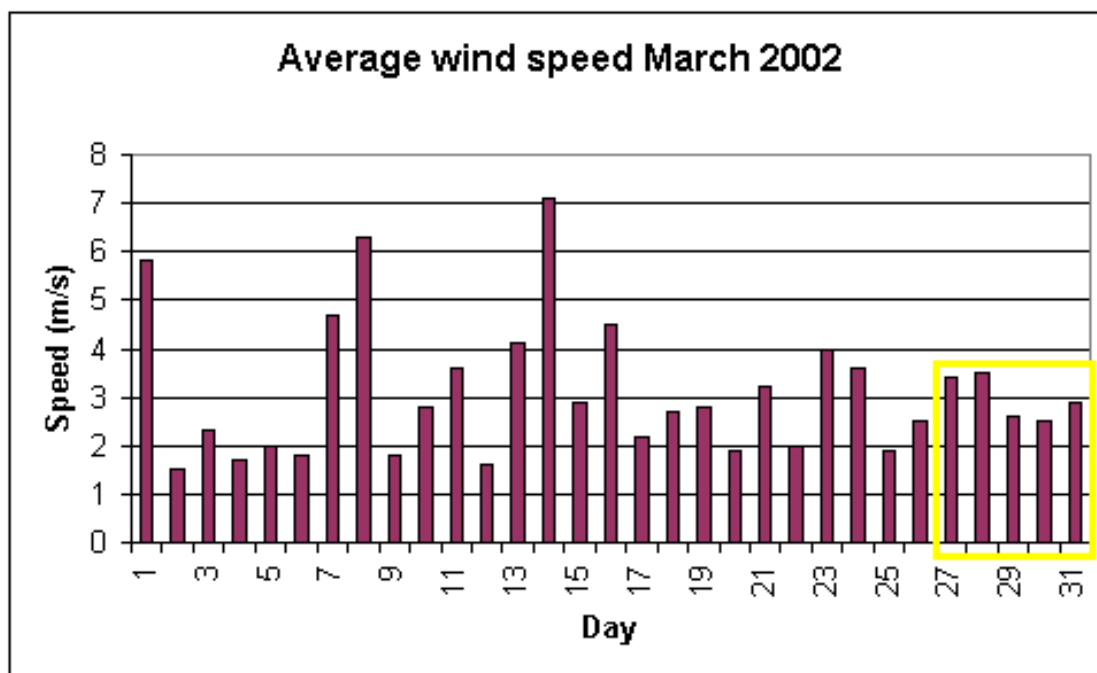
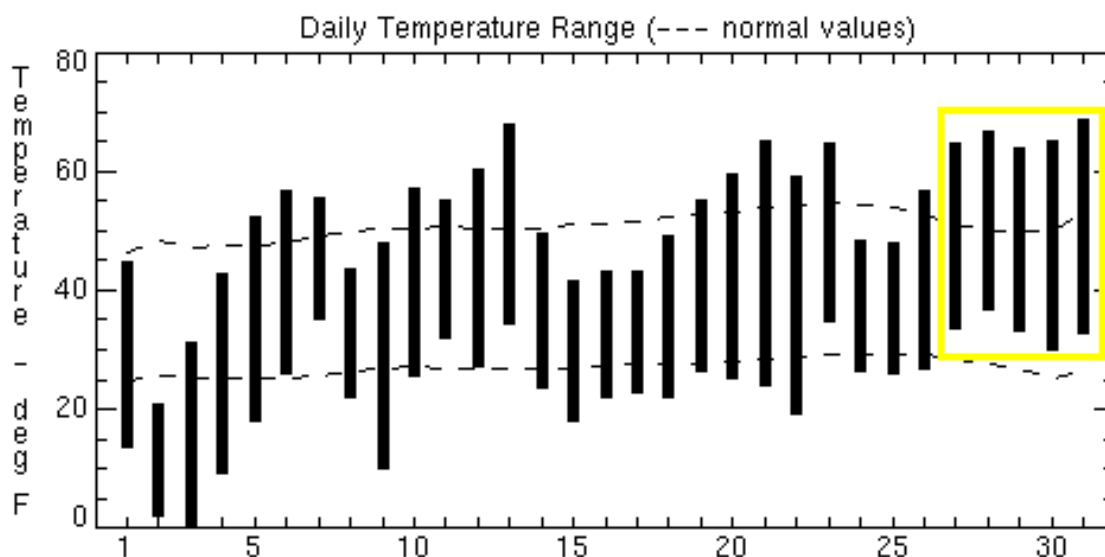
June 16th-20th, 2001: High conditions. Slightly higher temperatures than normal, with average wind speeds nearly, and slightly over, 3 m/s (6.7 mph). In actual data 0.05 inches of precipitation was recorded on the 19th.

Weather Summary for July 2001 **Los Alamos, NM, TA-6 Station, Elevation 7424 ft**

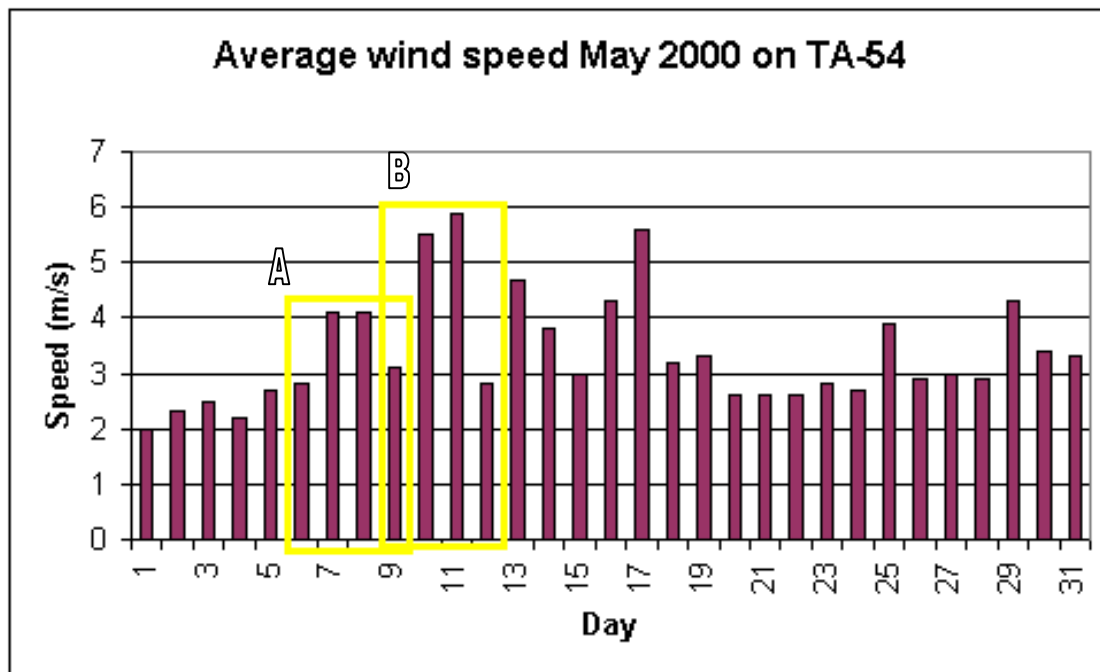
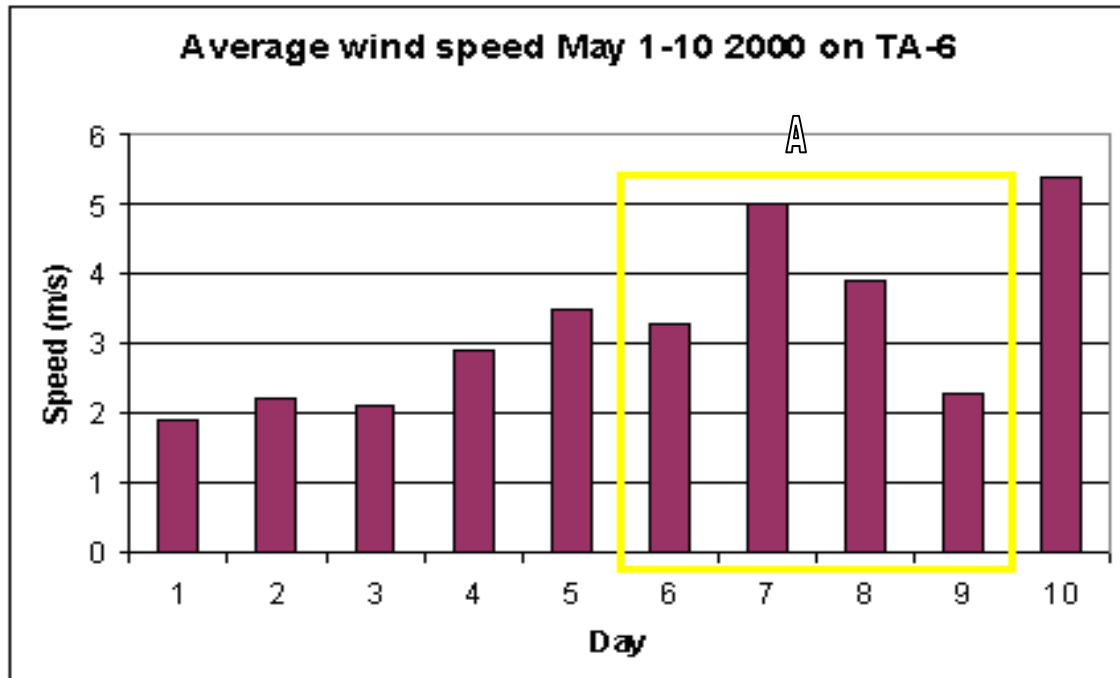


July 18th-22nd, 2001: Low conditions. Normal temperatures, average wind speeds mostly below 2.0 m/s (4.5 mph). In actual data 0.6 inches of precipitation was recorded on the 19th and 0.05 inches on the 22nd.

Weather Summary for March 2002 **Los Alamos, NM, TA-6 Station, Elevation 7424 ft**



March 27th-31st, 2002: High conditions. Temperatures much higher than normal and average winds nearly at and above 3 m/s (6.7 mph).



A- May 6th-9th, 2000 (Cerro Grande Fire): High to Extreme. Average wind speeds above 4 m/s (8.9 mph).

B- May 9th-12th, 2000 (Cerro Grande Fire): Extreme. Average wind speeds above 5 m/s (11.1 mph)

Attachment 2

Summarized characteristics of typical weather and wind conditions.

TA-6 Weather Station

Condition	Low	Moderate			High		High-Extreme	Extreme**
Dates	July 18-22, 2001	April 26-30, 2001	May 8-12, 2001	May 23-27, 2001	June 16-20, 2001	March 27-31, 2002	May 6-9, 2000	May 9-12, 2000
Avg High Temp (Deg F)	79	70	73	79	86	66	75	77
Avg Low Temp (Deg F)	55	43	46	50	55	34	48	45
Avg Wind Speed (mph)	4.23	5.97	5.79	6.37	6.55	6.64	8.09	8.58
Avg Max Wind Gust (mph)	21.97	29.19	26.96	29.99	27.14	30.17	33.16	36.21
Avg Wind Gust Direction (degrees)	300	285	254	193	201	242	261	240
Std Dev of Wind Speed* (mph)	2.60	2.80	2.82	2.46	2.44	4.08	3.24	4.41
Std Dev of Wind Direction* (degrees)	111.93	82.70	80.97	97.13	68.19	73.26	50.44	55.58
Avg High Humidity (percent)	85	78	73	51	45	54	42	62
Avg Low Humidity (percent)	33	21	17	10	8	11	10	6

*Std Dev derived from data gathered between 9:00-18:00 each day. **TA-6 weather station stopped acquiring data on May 11, 2000, at 2:00. Data averages based on the 9th and 10th.

TA-54 Weather Station

Condition	Low	Moderate			High		High-Extreme	Extreme
Dates	July 18-22, 2001	April 26-30, 2001	May 8-12, 2001	May 23-27, 2001	June 16-20, 2001	March 27-31, 2002	May 6-9, 2000	May 9-12, 2000
Avg High Temp (Deg F)	86	73	79	86	90	70	81	79
Avg Low Temp (Deg F)	55	39	45	48	48	30	45	43
Avg Wind Speed (mph)	5.04	6.42	6.46	7.00	7.80	6.91	7.85	9.64
Avg Max Wind Gust (mph)	23.35	28.83	25.58	28.39	29.46	31.06	36.15	38.16
Avg Wind Gust Direction (degrees)	220	224	220	238	222	197	236	232
Std Dev of Wind Speed* (mph)	2.75	3.81	3.32	2.67	3.98	3.81	3.73	5.39
Std Dev of Wind Direction* (degrees)	104.84	64.59	70.15	96.33	61.76	70.58	56.62	69.35
Avg High Humidity (percent)	86	87	78	53	59	57	45	46
Avg Low Humidity (percent)	24	18	16	6	6	8	8	4

*Std Dev derived from data gathered between 9:00-18:00 each day

TA-49 Weather Station

Condition	Low	Moderate			High		High-Extreme	Extreme
Dates	July 18-22, 2001	April 26-30, 2001	May 8-12, 2001	May 23-27, 2001	June 16-20, 2001	March 27-31, 2002	May 6-9, 2000	May 9-12, 2000
Avg High Temp (Deg F)	82	72	75	82	88	70	79	77
Avg Low Temp (Deg F)	57	45	46	52	57	37	50	46
Avg Wind Speed (mph)	5.88	7.89	7.53	8.11	8.82	8.02	8.97	11.92
Avg Max Wind Gust (mph)	25.49	31.51	25.98	30.88	31.42	35.43	36.43	40.27
Avg Wind Gust Direction (degrees)	231	237	113	299	205	222	239	234
Std Dev of Wind Speed* (mph)	3.38	3.25	3.69	3.11	3.90	3.94	4.30	6.94
Std Dev of Wind Direction* (degrees)	112.07	68.50	77.53	97.41	64.14	67.59	39.30	55.44
Avg High Humidity (percent)	83	79	70	49	49	52	38	37
Avg Low Humidity (percent)	28	19	16	9	7	10	8	3

*Std Dev derived from data gathered between 9:00-18:00 each day

Pajarito Mountain Weather Station

Condition	Low	Moderate			High		High-Extreme	Extreme
Dates	July 18-22, 2001	April 26-30, 2001	May 8-12, 2001	May 23-27, 2001	June 16-20, 2001	March 27-31, 2002	May 6-9, 2000	May 9-12, 2000
Avg High Temp (Deg F)	64	55	61	66	73	54	59	59
Avg Low Temp (Deg F)	50	37	41	46	50	34	41	36
Avg Wind Speed (mph)	9.40	14.62	13.10	14.22	15.29	15.33	21.17	25.18
Avg Max Wind Gust (mph)	25.05	33.42	37.97	37.88	38.10	43.09	50.30	53.75
Avg Wind Gust Direction (degrees)	200	253	156	215	237	236	298	200
Std Dev of Wind Speed* (mph)	4.84	4.65	4.35	4.92	5.37	6.14	7.34	13.64
Std Dev of Wind Direction* (degrees)	120.14	73.40	86.08	102.04	59.96	72.10	27.89	55.34
Avg High Humidity (percent)	91	79	84	53	55	54	54	64
Avg Low Humidity (percent)	51	32	27	18	12	18	17	13

*Std Dev derived from data gathered between 9:00-18:00 each day

Attachment 3

Fuels characteristics for ponderosa pine forests and piñon-juniper woodlands.

Prescription	TPA	Red TPA%	FM	Canopy ht	Canopy %	Crown ht	Canopy BD
Unthinned	554	NA	9	56.51	73.15	9.25	0.2125
General	100	81.95	9	57.62	13.20	11.10	0.0384
Fuelbreak	50	90.97	9	58.73	6.60	11.56	0.0192
Defensible	25	95.49	9	60.25	3.30	12.03	0.0096
Powerline	5	99.10	9	22.42	0.66	12.49	0.0019

Unthinned conditions are based on plot data collected in 2001.

Reduction of fuels in thinned conditions are proportional to the unthinned conditions.

TPA = Trees per acre

Red TPA% = The percentage reduction of trees per acre as compared to unthinned conditions

FM = Fuel model (Anderson 1982)

Canopy ht = Canopy height (ft)

Canopy % = Canopy cover (%)

Crown ht = Crown height (ft)

Canopy BD = Canopy bulk density (kg/m^3)

Prescription	TPA	Red TPA%	FM	Canopy ht	Canopy %	Crown ht	Canopy BD
Unthinned	524	NA	6	15.85	31.78	2.73	0.0142
General	50	90.46	6	18.55	3.03	3.28	0.0014
Fuelbreak	50	90.46	6	18.55	3.03	3.41	0.0014
Defensible	25	95.23	6	20.42	1.52	3.55	0.0007
Powerline	5	99.05	6	22.42	0.30	3.69	0.0001

Unthinned conditions are based on plot data collected in 2001.

Reduction of fuels in thinned conditions are proportional to the unthinned conditions.

TPA = Trees per acre

Red TPA% = The percentage reduction of trees per acre as compared to unthinned conditions

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Canopy BD = Canopy bulk density (kg/m^3)

